Informational Leaflet **141**

FORECAST OF THE 1970 KODIAK AREA PINK SALMON RUN

By:

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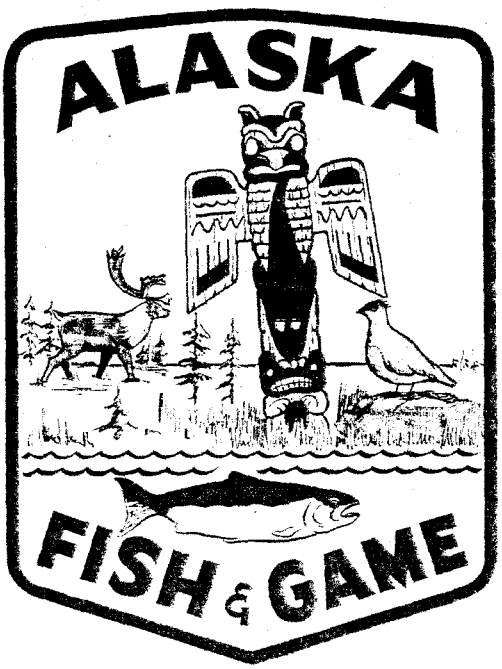
February 19, 1970



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DEPARTMENT OF FISH AND GAME

SUBPORT BUILDING, JUNEAU 99801

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By

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INTRODUCTION

Pink salmon (Oncorhynchus gorbuscha) mature at age two; consequently, distinct stocks return on alternate years. The even-year returns of pink salmon to the Kodiak Island area have comprised the dominant cycle since 1948, although decreasing numbers have returned to this area since the high 1962 return. Recent odd-year returns have been characterized by large deviations from the average.

Forecasts of recent returns to Kodiak Island have been presented since 1966 (Hennick, 1966, 1967; Hennick and Edfelt, 1968, 1969). These forecasts have been sufficiently accurate for use by management and the fishing industry.

Past forecasts have been derived by various means. The escapement-return relationship has been used with variable success. Another approach relates climatological data (temperature, precipitation) with survival of eggs and fry but is difficult to interpret quantitatively. Neave (1953) lists causes of pink salmon mortality experienced in the freshwater phase of life. These include predation on unspawned adults, adult death from insufficient water or other barriers, loss through egg retention, loss of eggs and fry from erosion, asphyxiation, freezing, dessication, superimposition (spawning fish excavating developing eggs from earlier spawners), fungus, predation and prolonged exposure to saltwater. These mortality factors may reflect variation of such a magnitude that parent escapement and environmental data observed can not be used to estimate, with sufficient accuracy, the abundance of adults returning in the forecast year.

1/ This investigation was partially financed by the Commercial Fisheries Research and Development Act (P.L. 88-309) under sub-project 5-4-R-6, Contract Number 14-17-0005-169.

Sampling the population after the major freshwater mortality factors have diminished is currently the best method of indexing the abundance of pink salmon. Pre-emergent fry indices have been obtained on six of seven successive years for Kodiak area streams. This paper presents the expected 1970 Kodiak pink salmon return based on these data. A brief prognostication for the Mainland District (Alaska Peninsula-Cape Douglas to Kilokak Rocks) is included.

METHODS

Stream Selection

The Kodiak-Afognak Island complex contains 220 salmon streams (ADF&G Stream Catalog, 1968). Nearly all receive pink salmon, but some only on even years. The number of streams selected for pre-emergent fry sampling depends, therefore, on the cycle year.

In the spring of 1969, 31 streams containing 81 percent of the 1968 escapement were chosen for sampling. Of these streams, 29 had been sampled in 1967 (the parent cycle).

Sampling Procedures

Pre-emergent fry sampling consists of hydraulically excavating young developing pink salmon from the stream bed. Noerenberg (1961) and McNeil (1964) described the technique, but the evolution of the sampling gear and procedures have been more recently reported by Smedley, et al. (1968).

In the Kodiak area, the selected streams are reached by chartered Bell 206-A Jet Ranger helicopter. A crew of three perform the sampling, beginning at an upstream location within the area utilized by spawning fish.

A gasoline driven centrifugal pump (4200 gph capacity) mounted on an aluminum stretcher with 18-inch legs is set in the middle of each spawning riffle comprising the study area. A 50 foot, one-inch hose connects the pump to a stainless streel probe with a venturi air intake. Another hose (4 feet long) with a fine screened filter, is attached to the pump intake.

Ten samples per riffle are taken within the 50 foot radius of the exhaust hose. Forty to 180 samples are taken in each stream, depending on the length of the spawning area.

The remainder of the sampling method is identical to Smedley's description. Water is pumped through the hose and venturi assembly where it mixes with air and is forced through the probe into the stream bed. The probe is "worked" 6-18 inches into the gravel within a circular frame enclosing 2 square feet of stream bed. One-eighth inch stainless steel screening covers the upstream half of the frame and the downstream half opens into a fine mesh tapered nylon net, 5 feet long. Eggs, fry, detritus and gravel are bubbled up and washed into the net. The heavier gravels settle out in the upstream portion of the net; eggs, fry and other light materials reach the cod end. A binder clamp at the cod end is released, and eggs, fry and other materials are transferred into a collecting pan where the live fry are identified and counted, and the dead eggs and fry noted. After each 10 samples the gear is carried downstream to the next sampling location.

Two crews operate simultaneously in different streams, each crew capable of sampling 1 to 3 streams per day.

Summarization of Data

The average number of live pink salmon fry per tenth square meter is estimated for each stream and all streams combined. These data can then be compared with pre-emergent fry density data from past years from which the total subsequent adult returns are known.

Total return is composed of the commercial catch plus the peak aerial escapement count. Aerial escapement counts may vary between observers. Since an observer will detect differences in population size of plus or minus 50 percent (Bevan, 1961) and because the number of surveys and streams flown vary each year, the escapement count for each year is herein considered as the peak estimate by one observer on 37 index streams.

Forecast Methods

The 1969 pre-emergent fry data will be used to develop a 1970 forecast of returning adult pink salmon by two methods: (1) Because of the higher level of pre-emergent fry sampling conducted in 1967 and 1969 compared to other years, only these data are used to obtain a 1970 forecast by applying the ratio of adult return to pre-emergent fry index for the 1967 sampling to the 1969 pre-emergent fry index. (2) Using all data available, a line is fitted to the pre-emergent fry index-adult return data. On the basis of this fitted line, the 1970 return is forecasted from the 1969 pre-emergent fry index.

RESULTS AND DISCUSSION

Kodiak-Afognak Area Forecast

The 1969 fry sampling results are presented in Table 1. The parent year (1967 sampling) densities are listed for comparison. For the twenty-nine streams sampled both in 1967 and 1969 the pre-emergent fry densities were 15.76/0.1m^2 and 29.06/0.1m^2 respectively. The 1970 return may be estimated by:

$$\frac{\text{1967 fry density (15.76/0.1m}^2\text{)}}{\text{1968 adult return (9.61 million)}} = \frac{\text{1969 fry density (29.06/0.1m}^2\text{)}}{\text{1970 adult return estimate}} \quad (1)$$

1970 adult return estimate = 17.69 million pink salmon.

A summary of the pre-emergent fry indices and the subsequent returns for all years appears in Table 2. The 1969 fry density was nearly twice that observed in 1967, although the indexed parent escapement counts were very similar (Appendix A).

Proceeding as described in method (2), the pre-emergent fry density-return data are graphed in Figure 1. The 1970 return, calculated from the equation $Y = 0.97 X - 4.82$, is estimated to be 23.5 million pink salmon. Note -- this forecast of 23.5 million should be evaluated with some caution. The 1969 fry density of 29.2 fry per .1m^2 is the largest observed to date, and as noted from Figure 1, this requires forecasting on the basis of a fry density level not previously observed. From a statistical standpoint, the resulting 1970 forecast is made with less confidence than a forecast based on a fry density of a level previously observed.

The 1970 pink salmon return is estimated to fall within the range of 17.7 million to 23.5 million fish. Any return within this range would probably result in the highest even-year commercial catch on record for the Kodiak area.

A ratio estimate, as used in method (1) above, can be used to obtain a forecast for the return to each of 5 major districts in the Kodiak-Afognak area (Table 3). The location of the sampling streams and the expected return by district appear in Figure 2.

The Afognak-Kizhuyak district is expected to receive 1.9 million pink salmon in 1970. The fry density obtained in Malina River indicates this stream should be the primary producer in this area.

Table 1. 1969 and 1967 Kodiak-Afognak Pre-emergent Fry Sampling Results.

Stream	YEAR 1969 No. 2 ft² Samples	1969 No. Fry	1969 1/ Density/0.1m²	1967 No. 2 ft² Samples	1967 No. Fry	1967 Density/0.1m²
Perenosa Creek	50	1,934	20.81	50	2,731	29.39
Paramanof Creek	59	2,484	22.65	65	4,284	35.16
Malina River	80	10,821	72.77	90	4,732	28.29
Afognak River	70	541	4.15	85	1,060	6.71
Marka Creek	90	2,846	17.01	95	3,727	21.11
Danger River	60	4,862	43.60	65	4,913	40.66
Elbow Creek	50	3,665	39.44	50	1,017	10.94
Bauman's Creek	40	4,277	57.52	40	494	6.64
Terror River	85	1,080	6.84	75	1,045	7.50
Uganik River	70	2,648	20.35	70	326	2.51
Little River	90	4,891	29.23	100	6,718	36.14
Zachar River	60	911	8.17	60	106	0.95
Brown's Lagoon	70	3,868	29.96	70	2,432	18.69
Uyak River	80	3,286	22.10	80	1,545	10.39
Karluk River	135	2,326	9.27	120	323	1.45
Sturgeon River	100	29	0.16	110	273	1.34
Red River	150	16,608	59.57	140	5,081	19.53
Dog Salmon River	60	10,724	96.16	60	3,585	32.15
Narrows Creek	50	1,602	17.24	50	331	3.56
Deadman River	80	8,822	59.33	80	2,063	13.87
Humpy R. (Upper)	60	83	0.74	60	47	0.42
Humpy R. (Lower)	40	1,206	16.22	60	2,703	24.24
Seven Rivers (Upper)	60	5,668	50.82	50	425	4.57
Seven Rivers (Lower)	70	2,558	19.66	50	2,621	28.20
Kaiugnak Creek	50	7,451	80.17	50	4,686	50.42
Barling River	50	114	1.23	--		---
Kiliuda Creek	50	1,073	11.55	60	1,283	11.51
Saltery River	80	98	0.66	90	113	0.68
Portage Creek	65	191	1.58	60	1,202	10.79
Hurst Creek	60	3,422	30.68	--		---
Sid Old's River	80	1,549	10.42	80	1,783	11.99
American River	85	6,055	38.32	100	2,148	11.56
Buskin River	90	7,862	47.00	90	3,738	22.35
Totals 2/	2,259	122,019		2,305	67,535	
Density/0.1m² 3/			29.06			15.76

1/ Density computed in tenth square meters for comparative purposes with other areas.
2/ Total is for only the 29 streams which were sampled in both years.
3/ Density is computed from totals and is not an average of all densities listed.

Table 2. Pre-emergent fry indices for all streams sampled (1963-1969) and subsequent returns (1964-1969).

	1963/64	1965/66	1966/67	1967/68	1968/69	1969/70
No. streams sampled	19	20	18	30	21	31
Fry density/0.1m^2 all streams	17.80	15.98	5.95	15.31	19.85	29.23
Subsequent catch plus indexed escapement (millions)	13.34	11.48	0.68	9.61	13.20	

The Westside District, which includes Terror, Uganik and Uyak bays should produce 3.6 million pink salmon. The Karluk-Red River District is expected to receive a record 6.3 million pinks. An exceptionally high fry density was obtained in Red River.

In the Alitak District fry densities were higher than the parent year in all streams except Humpy River where nearly the entire stream bed was observed frozen. However, Deadman and Dog Salmon rivers, each with excellent fry densities, will contribute most of the 3.4 million pinks expected in the Alitak area.

The Eastside-Chiniak District is expected to receive a strong return of 5.2 million pink salmon. The Chiniak Bay drainage should produce exceptionally well.

The summation of these district forecasts is 20,230,000 pink salmon, near the mid-point of the expected range.

District forecasts have at times been subject to error because they assume a projected pattern of catch similar to that of the parent year. Since timing and migration routes of the run, weather and regulations all affect the commercial fishing effort, fish destined for a particular district are often caught in neighboring districts. With these reservations in mind the trend in 1970 is for good to excellent returns in all five districts.

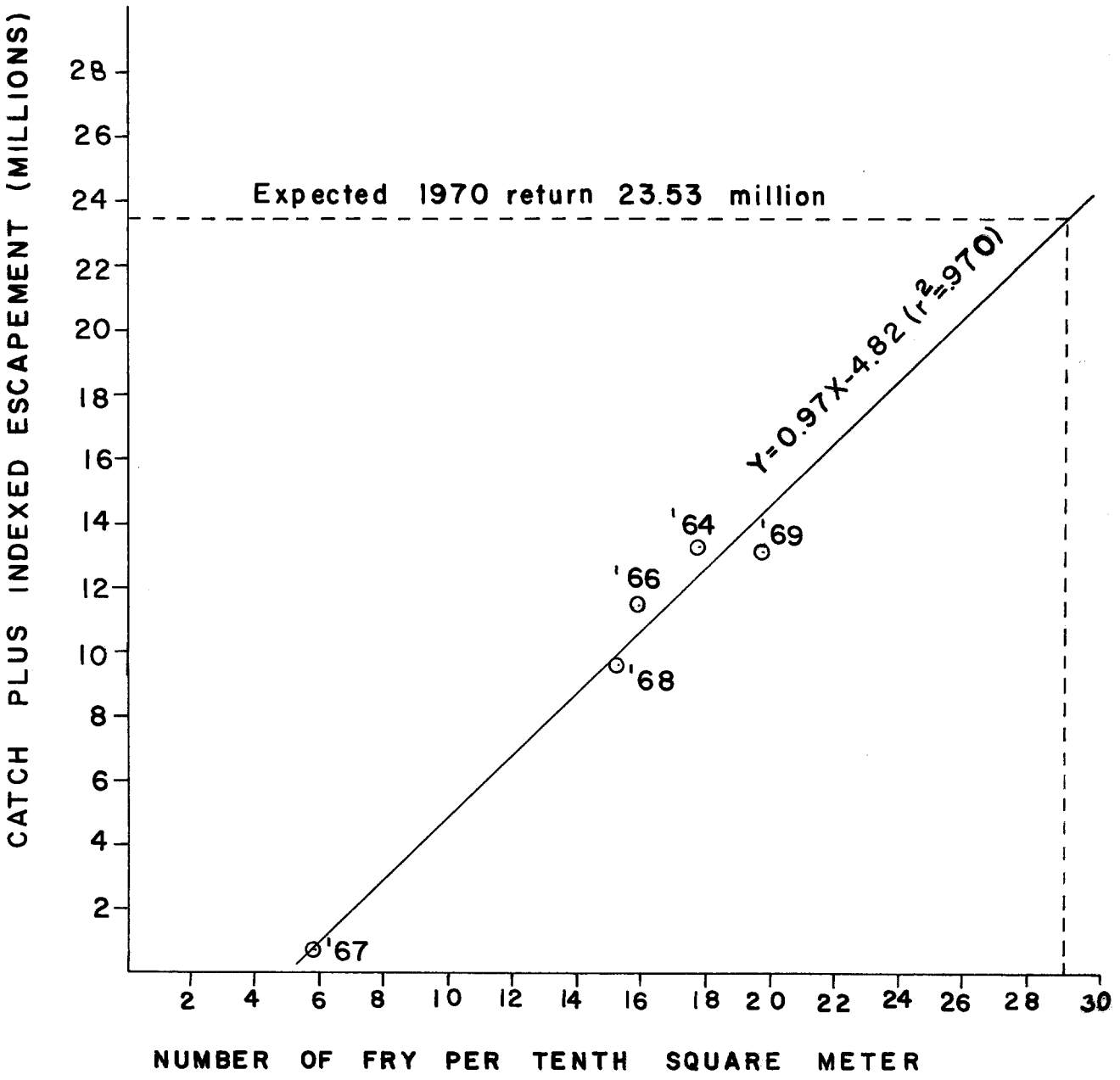

FIGURE 1.--Relationship between pre-emergent pink salmon fry densities 1963-1969 and subsequent return 1964-1969, Kodiak Area.

Table 3. Kodiak area pink salmon, 1967-1969 fry sampling summary, density ratios and expected 1970 return by district.

	Number streams sampled	1967			1969			Ratio 1969/1967	1968 return (millions)	Expected 1970 return (millions)
		No. samples	No. fry	Fry per sample	No. samples	No. fry	Fry per sample			
Afognak-Kizhuyak	7	500	22,464	44.93	459	27,153	59.16	1.32	1.41	(1.86)
Westside	7	495	12,666	25.59	495	20,961	42.35	1.65	2.15	(3.55)
Karluk-Red River	3	370	5,677	15.34	385	18,963	49.25	3.21	1.96	(6.29)
Alitak	4	310	8,729	28.16	290	22,437	77.37	2.75	1.22	(3.36)
Eastside-Chiniak	8	630	18,017	28.60	630	32,505	51.60	1.80	2.87	(5.17)
Total	29								9.61	(20.23)

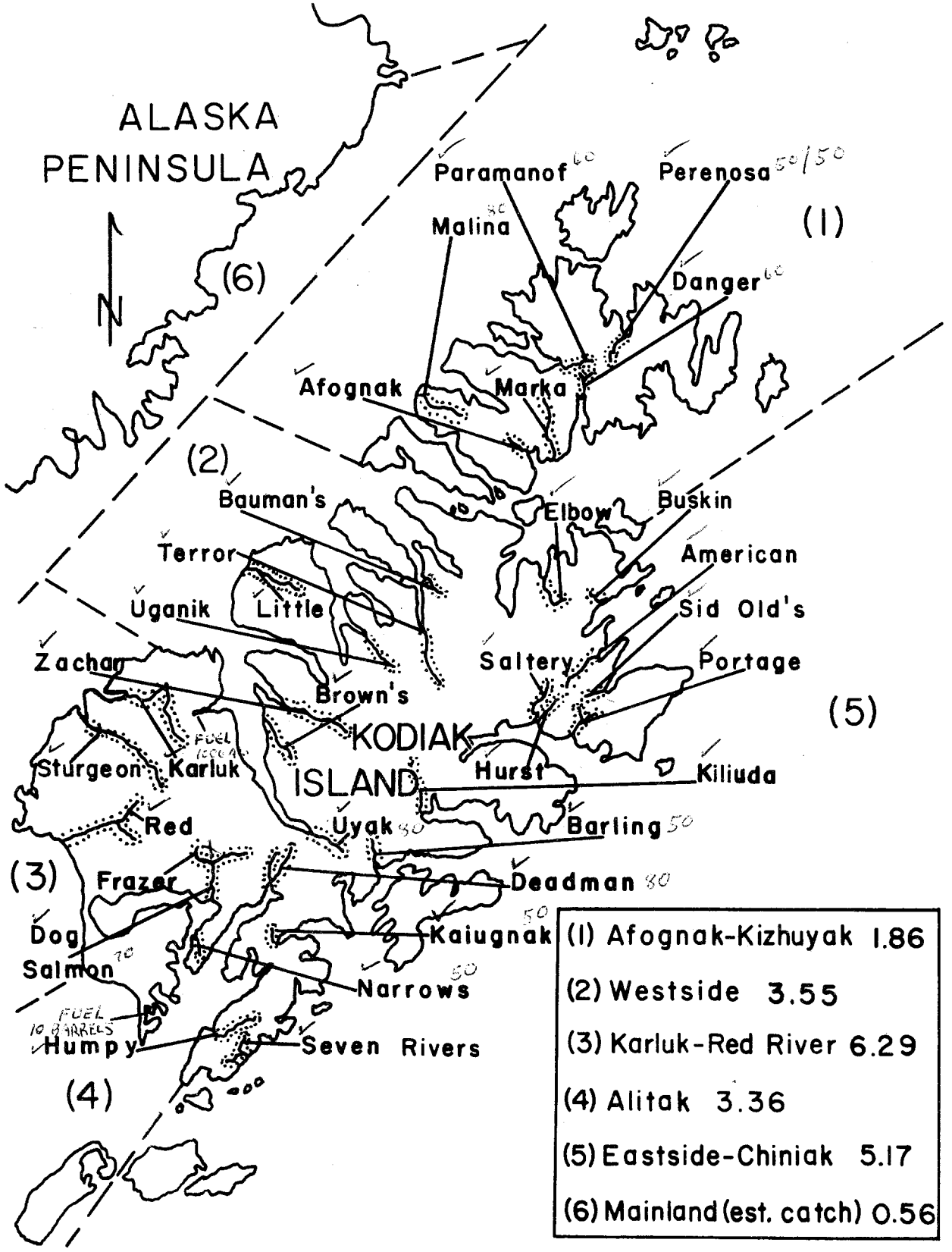

FIGURE 2.--Kodiak Area pre-emergent fry sampling streams and expected 1970 return by district (millions of pink salmon).

Mainland District

That area of the Alaska Peninsula, from Cape Douglas to Kilokak Rocks, is defined as the Mainland District of the Kodiak management area. The area contains approximately 50 salmon streams, none of which are sampled annually for abundance of pre-emergent pink salmon fry. Also, since the escapement history is incomplete both in number of surveys and number of streams surveyed each year, no valid escapement-return relationship can be developed. Therefore, the expected catch in 1970 is the average of the even-year catches since 1960 or 563,000 pink salmon.

Anticipated Commercial Harvest

If the 1970 return corresponds closely to the forecasted level of 20.2 million fish, an estimated 16.6 million pink salmon will be available for harvest in the Kodiak Island area. In addition, an average even-year harvest of 563,000 pink salmon is projected for the Mainland District. These two estimates combine to yield an indicated commercial harvest of approximately 17.2 million pink salmon for the Kodiak area in 1970.

SUMMARY

Recent pink salmon forecasts for the Kodiak area have been sufficiently accurate for use by management and the fishing industry.

Pre-emergent fry densities have been the most reliable indicators of subsequent adult pink salmon abundance because sampling occurs after the major freshwater mortalities have occurred.

In 1969, 31 streams were sampled for abundance of pre-emergent fry. Forecasts were obtained by two methods:

(1) A ratio of fry density to return for 29 comparable streams sampled in 1967 and 1969 resulted in a 1970 forecast of 17.7 million pink salmon.

(2) Using all years for which data are available, a regression of fry densities on return yielded an estimate of 23.5 million pinks for the 1970 return.

With technique (1) a forecast for each district was developed.

The Afognak-Kizhuyak area is expected to receive 1.9 million pink salmon in 1970. The Westside forecast is for 3.6 million pink salmon. The estimate for the Karluk-Red River area is 6.3 million; the Alitak region should receive a 3.4 million and the Eastside-Chiniak area estimate is 5.2 million.

The summation of the district estimates is 20,230,000 pink salmon, which is near the mid-point of the expected range of 17.7 to 23.5 million.

District projections should be accepted with some reservation because the forecast technique assumes the catch pattern in 1970 will be similar to that of 1968.

The only estimate for the Mainland District is that the 1970 catch should be average for an even-year cycle. This would indicate a commercial catch of approximately 563,000 salmon.

Assuming that the actual pink salmon return in 1970 is near the 20.2 million forecast, approximately 17.2 million pink salmon would be available for commercial harvest in the Kodiak area (including the Mainland District).

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APPENDIX A KODIAK AREA INDEXED ESCAPEMENT (37 STREAMS) 1962-1969

Index streams	1962	1963	1964	1965	1966	1967	1968	1969
Perenosa*	27,300	3,200	37,000	10,000	20,000	3,000	6,000	25,000**
Paramanof*	20,000	700	18,000	2,200	17,000	200	27,000	2,900**
Malina*	60,000	0	35,000	200	19,000	--	13,000	1,000**
Afognak*	75,000	2,000	45,000	900	26,000	1,000	10,000	12,000**
Marka*	65,000	4,000	22,000	3,500	35,000	2,500	15,000	12,000**
Danger*	50,000	2,500	11,000	2,000	25,000	5,000	15,000	7,600**
Elbow*	15,000	5,000	11,000	3,200	13,000	11,000	11,000	9,000
Kizhuyak	8,000	5,000	5,000	4,300	4,300	12,000	2,000	15,000
Bauman's*	17,000	--	8,000	1,800	9,000	4,200	6,000	7,000
Terror*	45,000	35,000	40,000	12,000	85,000	35,000	45,000	55,000
Uganik*	100,000	45,000	75,000	12,000	80,000	40,000	21,000	60,000
Little*	45,000	--	50,000	--	37,000	--	45,000	--
Zachar*	25,000	89,000	24,000	8,000	16,000	2,700	15,000	17,000
Brown's*	96,000	200	65,000	300	24,000	300	35,000	2,600**
Uyak*	65,000	40,000	100,000	60,000	40,000	75,000	35,000	95,000
Karluk*	350,000	--	525,000	--	225,000	--	140,000	--
Sturgeon*	35,800	--	140,000	--	90,000	--	30,000	--
Red*	1,100,000	--	425,000	--	175,000	--	300,000	--
Dog Salmon*	83,000	60,000	50,000	36,000	21,000	11,000	12,000	45,000
Narrows*	18,000	1,700	4,200	2,500	600	3,500	2,800	6,000**
Horse Marine	3,000	0	2,600	--	800	300	2,400	--
Deadman*	25,000	22,000	18,000	30,000	12,000	70,000	20,000	65,000
Sulua	12,000	16,000	8,000	7,000	6,000	7,000	6,000	4,500
Old Tom's	0	--	--	200	300	2,300	5,500	3,200
Humpy*	300,000	115,000	80,000	175,000	36,000	60,000	120,000	55,000
Seven*	128,000	40,000	10,000	60,000	16,000	25,000	55,000	33,000
Kaiugnak*	34,000	7,000	10,000	8,500	10,000	8,000	10,000	4,000
Barling*	40,000	8,000	60,000	3,500	20,000	12,000	28,000	20,000
Midway	6,000	5,000	--	1,000	4,500	100	6,000	1,900**
Shearwater	500	50	--	50	900	500	500	60
Kiliuda*	18,700	5,000	17,000	1,100	9,000	1,700	5,000	2,000
Eagle Harbor	26,700	600	13,000	1,000	8,000	3,000	10,000	1,200
Saltery*	70,000	35,000	28,000	20,000	17,000	36,000	5,000	50,000
Portage*	37,000	--	--	--	22,000	--	42,000	--
Sid Old's*	70,000	10,000	30,000	6,000	35,000	19,000	55,000	36,000
American*	21,000	11,000	25,000	9,000	24,000	14,000	25,000	70,000
Buskin*	209,000**	7,200**	93,000**	25,600**	20,000**	28,000**	42,000**	66,500**
	3,301,000	575,150	2,084,800	506,850	1,203,400	493,300	1,223,200	784,460

* Denotes pre-emergent fry sampling stream

** ADF&G count, all others FRI

APPENDIX B KODIAK AREA PINK SALMON RETURNS - 1962-1969

INDEXED ESCAPEMENT (37 STREAMS)

AREA	1962	1963	1964	1965	1966	1967	1968	1969
Afognak-Kizhuyak	320,300	22,400	184,000	26,300	159,300	34,700	99,000	84,500
Westside	393,000	209,200	362,000	94,100	291,000	157,200	202,000	236,600
Karluk-Red River	1,485,800	0	1,090,000	0	490,000	0	470,000	0
Alitak	441,000	214,700	162,800	250,700	76,700	154,100	168,700	178,700
Eastside-Chiniak	660,900	128,800	286,000	135,700	186,400	147,300	283,500	284,700
Total	3,301,000	575,100	2,084,800	506,800	1,203,400	493,300	1,223,200	784,500

CATCH

	1962	1963	1964	1965	1966	1967	1968	1969
Afognak-Kizhuyak	2,281,000	648,000	1,402,000	138,000	3,200,000	28,000	1,315,000	413,000
Westside	1,676,000	873,000	2,526,000	643,000	3,705,000	22,000	1,951,000	608,000
Karluk-Red River	3,990,000	21,000	3,693,000	19,000	777,000	6,000	1,495,000	30,000
Alitak	1,887,000	1,527,000	1,419,000	1,136,000	433,000	85,000	1,046,000	3,754,000
Eastside-Chiniak	3,154,000	2,413,000	2,217,000	887,000	2,162,000	45,000	2,583,000	7,615,000
Total	12,988,000	5,482,000	11,257,000	2,823,000	10,277,000	186,000	8,390,000	12,420,000

TOTAL RETURN - CATCH AND ESCAPEMENT INDEX

	1962	1963	1964	1965	1966	1967	1968	1969
Afognak-Kizhuyak	2,601,300	670,400	1,586,000	164,300	3,359,300	62,700	1,414,000	497,500
Westside	2,069,000	1,082,200	2,888,000	737,100	3,996,000	179,200	2,153,000	844,600
Karluk-Red River	5,475,800	21,000	4,783,000	19,000	1,267,000	6,000	1,965,000	30,000
Alitak	2,328,000	1,741,700	1,581,800	1,386,700	509,700	239,100	1,214,700	3,932,700
Eastside-Chiniak	3,814,900	2,541,800	2,503,000	1,022,700	2,348,400	192,300	2,866,500	7,899,700
Total	16,289,000	6,057,100	13,341,800	3,329,800	11,480,400	679,300	9,613,200	13,204,500